DESIGN AND CONSTRUCTION OF PORTABLE SURFACE AERATION PUMP FOR TANKS AND SMALL PONDS

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ABSTRACT

The maintenance of adequate dissolved oxygen level is very important in the economy of any aquaculture system. An easy to construct aerating device was constructed using 0.5hp water- pump, shower rose, Styrofoam, and rubber hose. The aerator works by the principle of drawing water from below and discharging it into the atmosphere as a spray. The spray is aerated as it splashes into the water surface. The aerating device have an average spray of 1.2 unit and doubles the dissolved oxygen content of 37.8m^3 tank in one hour.

INTRODUCTION

Low concentration of dissolved oxygen (DO) is the major variable limiting the production of fish, shrimp, and other species in intensive aquaculture operations. (boyd & Watten, 1989).

The maintenance of adequate dissolved oxygen levels in aquaculture is a serious environmental problem (Colt and Tschobanoglobus, 1981). In the absence of deliberate/ accidental poisoning dissolved oxygen is the single most important and critical water quality parameter for fish in ponds and other culture systems. For any culture system especially for hatching and rearing fry , if there is no aeration system it can lead to no hatching and mortality of fry .Thus, dissolved oxygen will determine survival and growth of fry

So it is advisable to aerate the culture medium as one of the management practices (Boyd and Lichkopper, 1978). Artificial aeration means increasing the oxygen content of all or part of the pond water to ensure the oxygen supply to the fish without limiting the production at a given management level (ADCP, 1984). Oxygen may be supplied in one of three ways, namely as air, pure oxygen gas or as a mixture of the two (oxygen-enriched air). When air is used, the process is called aeration, when oxygen or oxygen enriched air is used the term oxygenation is employed (Colt and Tschobanoglous, 1981).

In Nigeria, many upcoming fish farmer cannot afford imported aerators such as blower .

There is need to develop simple aerating device from locally available materials that they can afford.

The aims of this study therefore, is using water pump thus serving a dual purpose of pump and aerator, which can be constructed on the farm a device that can be easily operated and portable to overcome temporary oxygen depletion in tanks and small ponds.

MATERIALS AND METHOD

The following materials were used for the construction of surface pump aerator

Electrical Materials:

1 - Petrolia pumping machine of 0.5 HP
2 - 6 yards of 3 core 16mm flexible cable wire
3 - 3- 13 Amp plug.

Plumbing Materials:

4- 2 numbers of 1" elbows
5 - 2 numbers of 1" nipples
- 21/2" bushing (thread)
6 A shower hose
7 - 1m of 3/4 " rubber hose
8- A plastic screen

Floating Materials used are:

- 10 18" x 10" plywood of 1/2"
- 11 11" x 8" x 6" Styrofoam (2) pieces
- II Aluminium sheet
- Brace iron metal (4) pieces
- 1 1/2" screws (8) pieces
- 9 a 1" bolts and nuts (8) pieces 9

The cost of these materials were:

Petrolla pump	N2,800.00
.Aluminium sheet	N 500.00
Styrofoam	N 600.00
Handle and anchor	N 230.00
Plumbing materials	N 390.00
Electric cable	N 130.00
Workmanship	N 500.00
Total	**N5,150.00**

prices as at 2001.

METHOD OF CONSTRUCTION

Six yards of flexible cable wire were connected to the pump, tested and found to be okay. One 1" nipple, 1" elbow, 1/2 of bushing thread and the shower rose were connected and tightly fitted to the outlet. The inlet part comprises of 1 ": nipple, 1" elbow, 3/4" rubber hose(lmetre) and plastic screen, all were closely fitted to the inlet space. An aluminium box (11"x 8"x 6") was constructed with Styrofoam (floater) inside it. An 1/2" plywood measuring 18"x 10" was drilled at four points centrally to form a base for the pump. The pump was then screwed with bolts and nuts onto the plywood. The floaters were attached firmly with the aid of brace iron metals and 1/2" screw to the plywood.

The surface aerator after construction was tested using the College circular ornamental tank of 39.8m3 in volume.

In ponds, aeration can be used to increase the carrying capacity at all time of the culture.

The designs of aeration systems for aquaculture will depend primarily on matching the system demands with the mass transfer characteristic of the aerators.

The primary function of water exchange in fish farming is to supply the fish with the oxygen they require for respiration. Natural waters contain only small quantities of oxygen because oxygen is relatively insoluble Ref and because air contains only 21% oxygen.

Large volume of water are required, therefore, to meet, the fishes' oxygen requirements, and this represents one of the most important constraints to the development of the fish farming industry (Sowerbutts and Forster, 1980).

In the practice of pond fish farming oxygen deficiency has been regarded as dangerous mainly because of mass losses of fish. But recent investigations have shown that decreased oxygen saturation can have serious effects on the economy of a fish farm as well. Ref Increase toxic effect of different toxic materials can not be neglected in water bodies with low oxygen supply. The low oxygen content disadvantageously influences both the food intake and the utilizations of food. Investigation have shown that lower than 25% oxygen saturation occurring before sunrise has a disadvantageous effect on fish growing. Keeping the dissolved oxygen content of the pond water nearly at the saturation level makes it possible not only to avoid mass mortality of fish but ensures better conversion rates and higher yields in intensive culture (ADCP, 1984). Aerators are designed to produce a large interfacial area by producing a short contact time between large volumes of air and water. The methods of achieving this may be classified in many ways.(Colt and Tschobanoglous, 1979).

VARIOUS TYPES OF PUMPED WATER AERATORS

1. SURF ACE AERA TORS:- which draw water from below the aerator and discharge it into the atmosphere as a spray. The spray is aerated in flight and it splashed into the water surface. Transfer efficiencies of 1.2-2.4kg oxygen lkh are achieved under standard conditions. (Colt and Tschobanoglous, 1979).

2. SURFACE AGITATORS:- Surface agitators which consist of various paddle-type derives, some with axis horizontal, others with a vertical axis. They operate in a similar fashion as surface aerators, but activity is principally at the water surface. Similar transfer efficiencies of1.2-2.4kg/kh are possible under standard conditions (Colt and Tschobanoglous, 1979).

3. VENTURIS, which air is draw into the throat by pumping water through the venturis- small bubbles are dispersed horizonally in the water. The pressure drop across the venturi can sometimes result in a high energy consumption giving lower transfer efficiencies and value of 0.6- 2.4kg oxygen/kh are reported under standard condition (Colt and Tschobanoglous, 1979).

In some venturi methods, air is blown rather than drawn into the jet to create a larger interfacial area, but this increases the power consumption. Nitrogen supersaturating is a possibility with venturi methods due to the water and air being subjecteed to rapid pressure changes. The submerged pump is a similar method of aeration to the venturi. Air is broken into small bubbles by a rotating impellers and violently mixed with the water.

4. IMPINGING WATER JETS:- They are simply water jets directed down onto the water surface forcing air bubbles down into the water. Because of their simplicity, they are commonly used in fish farming for overcoming temporary oxygen shortages. With careful attention to pumping capacities and water velocities; transfer efficiencies of up to 2.4kg oxygen/kWh are possible under standard conditions, and due to their simplicity, (Sowerbutts and Forster, 1980).

Diffused air systems, venturi systems, and mechanical aerators may produce high levels of noise. It is not unreasonable to suspect that in recycled or raceway systems aeration noise may have an adverse effect on the fish. In pond systems, the fish may be able to avoid the noise (Colt and Tschobanoglous).

The safety of aerators most be an important design paramet,er. All will require some energy in put, most likely in the form of electricity. The hazard of electrical shock will be greatest in the floating aerators, paddle wheel aerators, and other types that may require water proof housing and water proof electrical cable. These aerators should be removed from the water for maintenance and repair (ADCP, 1984).

With the increasing of the accelerated biological. activity (intensive manuring, feeding, high stocking desnsity, the natural oxygen supply becomes more and more insufficient and will be a limiting factor in production. Intensive aeration of fish ponds has not only a life-saving role, but it becomes one of the basic factors of production, and ensuring oxygen supply makes possible the maximal utilisation of the given biological possibilities (ADCP, 1984.

RESULTS

Plate 2 and figure 2 shows the operation of the surface aerating pump. The college circular ornamental tank of39.8m3 volume of water was used to test the effectiveness of the aerator.

Table 1 shows the result of the surface aerating pump operation. It was tested in the day time (1.00 p.m.) for two hours. The length of spray jet was 0.76m. After one hour of operation, dissolved oxygen of water rose to 6.1 mg/l from the initial dissolved oxygen of 4.8mg/l. Thus, it can be seen that an average aeration of about 1.4mg/l/hr was obtained.

TABLE 1: Aeration rate during the operation of surface aerating pump taken in the afternoon (1.00 p.m. -3.00 p.m.) in circular tank of 39.8m3 in volume.

Duration (hour)	CONTROL Dissolved Oxygen (mg/l)	TREATMENT Dissolved Oxygen (mg/l)	Difference (mg/l)
0	4.8	4.8	0
1	4.8	6.1	1.3
2	4.8	7.6	2.8
Mean	4.8	6.17	

Analysis of variance using student's T-test was carried out. There was no significant difference between the mean of the treatment and the control.

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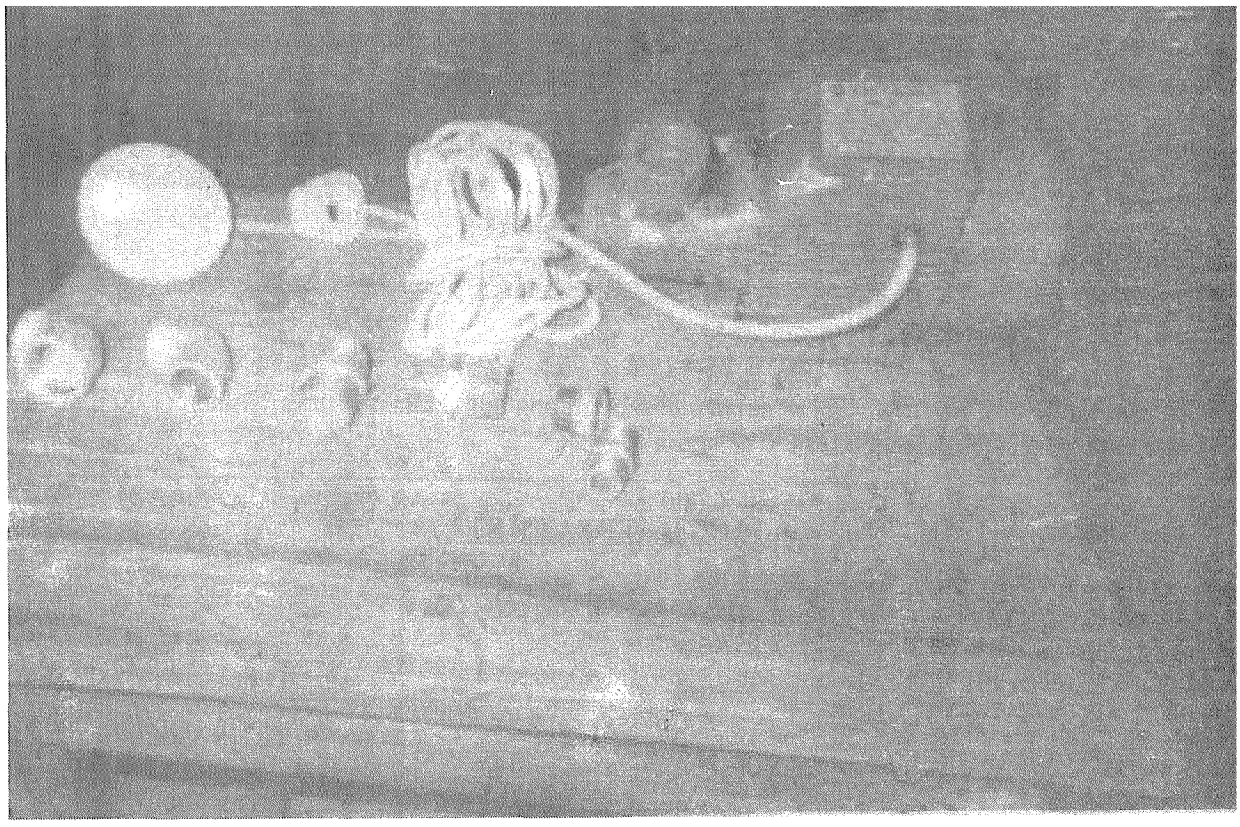

Plate 1

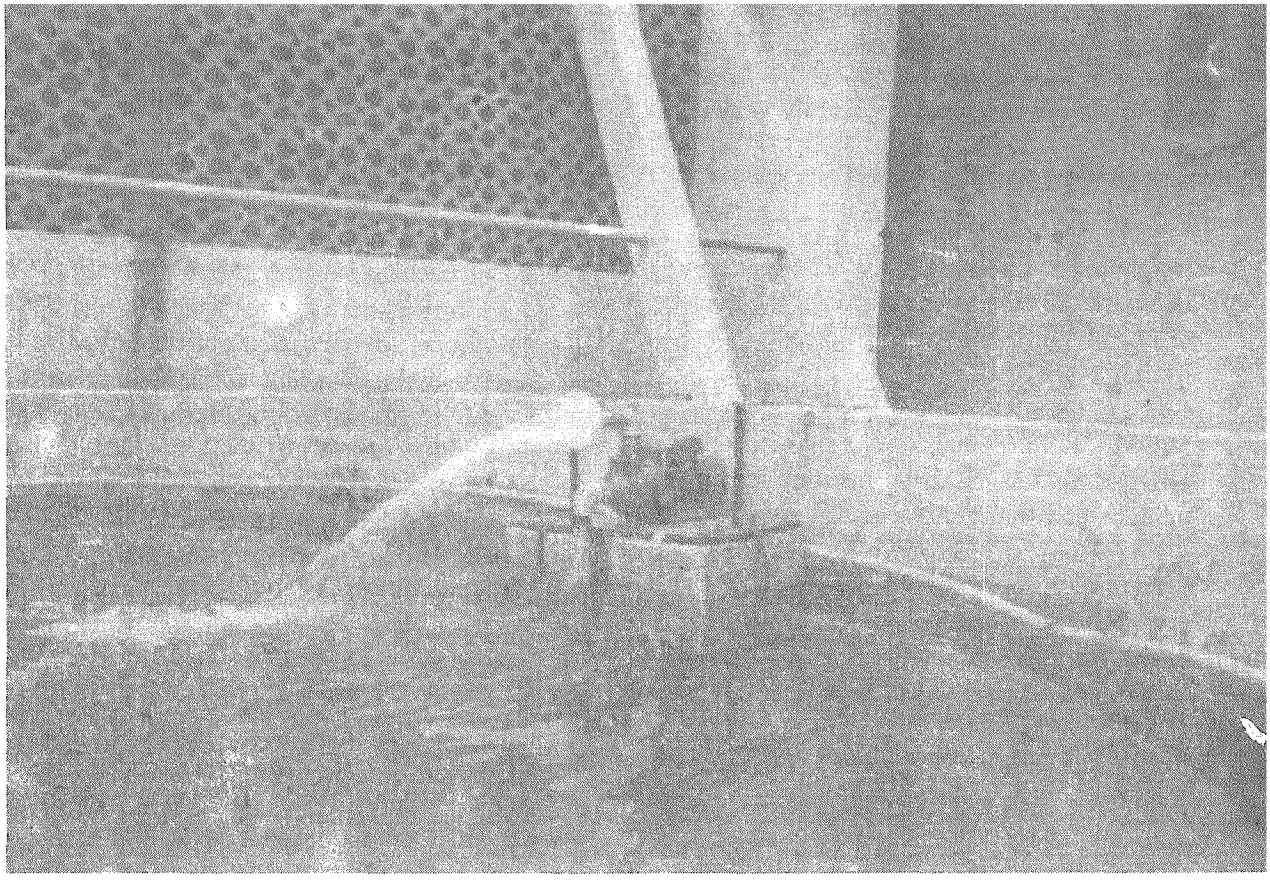

Plate 2